PATENT SPECIFICATION (11) 1 463 004

1 463 004

(21) Application No. 4178/74 (22) Filed 29 Jan. 1974
(31) Convention Application No. 22 574/73 (32) Filed 30 Jan. 1973 in
(33) Bulgaria (BU)
(44) Complete Specification published 2 Feb. 1977
(51) INT. CL.² B23K 9/12
(52) Index at acceptance B3R 32D2 32J

(54) A FEED ARRANGEMENT FOR WELDING ELECTRODE WIRE

(71) We, DSO "METALOLEENE" of Boulevard Totleben 34, Sofia, Bulgaria, a State Economic Corporation organised under the Laws of Bulgaria, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a feed arrangement suitable for feeding a welding electrode which is in the form of a wire, the arrangement comprising two motor driven feeding mechanisms arranged at opposite ends of a flexible tube through which a wire-form electrode is to be fed in the direction to one from the other of the feeding mechanisms. Such an arrangement is particularly applicable for feeding electrode wire over long distances.

Arrangements for feeding electrode wire over long distances are known to us in Bulgaria in which at both ends of the flexible tube there are one or two conventional wire-feeding mechanisms i.e. mechanisms in which the wire feeding is effected by clutching the electrode wire between rollers, the axles of these rollers being perpendicular to the direction of feeding. In the known feeding arrangements the rollers are driven by an electric motor by means of a worm-type reduction gear of high transmission ratio. The rate of feeding of the electrode wire is stabilized by stabilizing the speed of both wire-feeding mechanisms. Because of the high transmission ratio of the reduction gear the electric motor practically operates under no load conditions, since the torque against which the motor shaft is working hardly changes when changes occur in the tension of the electrode wire or in the frictional resistance exerted on the electrode wire by the inner wall of the flexible tube. In the case of a difference in the speeds of both wire-feeding mechanisms, due most frequently to an abrupt bending or straightening of the connecting hose, which leads to a relative elongation or shortening of the electrode wire passing through it, considerable mechanical forces are produced which most frequently cause a slip between the rollers of the feeding mechanisms and the electrode wire. The slip can be in the direction of feeding of the wire or backwards. This can cause the quality of the electrode wire to be impaired as a result of the slip, and also has an effect on the quality of the weld by the appearance of so-called buttons.

Attempts have been made to overcome these problems by designing the rollers of the conventional feed mechanisms to have a less damaging effect on the electrode wire.

A further attempt at improvement has been the use of a circuit of synchronous operation of both motors, while using two motors of different type, such as a shunt d.c. and a series motor. Other, similar, attempts have been made at equalizing the speeds of the motors at the two ends of the flexible tube. One such attempt has utilised an abrupt change of the relative length of the electrode wire between the wire-feeding mechanisms to self-regulate its speed of feeding by utilising the resultant slip between the rotor and stator of at least one of the drive motors for the wire-feeding mechanisms. This has not been fully successful, however, because the mechanical inertia of the reduction gear, connecting the motors to their wire-feeding rollers, is very high. The same problem arises also when trying to provide an equal speed of both motors.

Further arrangements are known to us in Bulgaria which compensate for differences occurring in the length of the electrode wire and the flexible tube by hydraulic means. The pulling and pushing wire-feed-

ing mechanisms are driven by a hydraulic gear, and in the case of a relative difference between the length of the electrode wire and the flexible tube, they provide a hydraulic slip (analogous to the slip produced in an electric motor) between the rollers of both wire-feeding mechanisms and the wire. A draw-back of this method of feeding is that the system does not respond very rapidly to changes, and in the case of abrupt resistances between the flexible tube and the electrode wire the uniformity of feeding is disturbed, and hence also the normal burning of the arc when welding. Moreover, the use of hydraulics in welding equipment complicates the work of the operator, i.e. the welder, because of the additional cables and tubes for the hydraulic system.

According to the present invention there is provided a feed arrangement suitable for feeding a welding electrode which is in the form of a wire, the arrangement comprising two feeding mechanisms arranged at opposite ends of a flexible tube through which a wire-form electrode is to be fed in the direction to one from the other of the feeding mechanisms, there being first and second electric motors arranged for driving the one and the other feeding mechanisms respectively, the first motor being operable to drive the one feeding mechanism at a substantially constant rate of electrode feed despite variation in mechanical resistance to the electrode feeding motion and the second motor being arranged to increase and decrease the speed of the other feeding mechanism in response to increase and decrease respectively of the value of the current drawn by the first motor, wherein said one of the two feeding mechanisms is a planetary roller feeding mechanism arranged such that the drive rollers thereof which are arranged to contact the electrode and apply feeding force to it are mechanically connected to the rotor of the associated drive motor without any reduction gearing being connected between said rollers and said rotor.

A planetary roller feeding mechanism is one in which a system of rollers rotates around the electrode wire to be fed. The rollers are in contact with the wire and are so angled that as the system of rollers rotates, the rollers themselves describe helical paths on the electrode wire surface and displace the wire axially as a result. There must be relative rotation between the electrode wire and the system of rollers (this relative rotation usually being provided by the roller system rotating and the electrode wire not rotating) for the electrode wire to be axially displaced.

The advantage in the invention arises from the fact that no reduction gear is required between the pulling planetary roller feeding mechanism and its drive motor. This is because a planetary roller feeding mechanism has a relatively low rate of axial feed as compared with its rotational speed. Since there is no reduction gear the drive motor at the pulling end is sensitive to changes in mechanical resistance to axial movement of the electrode wire, and this enables the current drawn by the pulling motor to provide a useful indication in dependence upon which to regulate the pushing motor to enable the pulling motor to maintain a constant rate of feed to the welding operative. Moreover, because the pulling motor has no associated reduction gear it can operate at higher torque than if reduction gears were provided. The higher torque means that the inventive arrangement can feed electrode wire over long distances more efficiently.

Particular designs of planetary roller feeding mechanisms are illustrated and described in Bulgarian Patent Specifications 10986 and 12045, which were both published in Great Britain before 1973. Two, more sophisticated, planetary roller feeding mechanisms are illustrated and described in British Patent Specification No. 1,320,356 which corresponds to Bulgarian Patent Specification No. 14017.

Preferably, each of the pulling and pushing mechanisms is a planetary roller mechanism.

The or each planetary roller wire-feeding mechanism may be driven by a separate d.c. motor with separate excitation.

When there are two such motors they may be controlled by two speed regulators, supplied by a common current source. The latter may be located in the source of welding current which, in view of the field of application of the wire-feeding mechanisms for long distances, is located near to the pushing wire-feeding mechanism. The speed regulator of the motor of the pulling mechanism regulates, in dependence upon the setting of a potentiometer, the rate of electrode feeding according to the requirements of the welder. It also stabilizes the rate of feeding of the electrode wire towards the weld, thus stabilizing also the conditions of welding. For its part, the regulator of the pushing motor receives a signal indicative of the loading of the pulling motor and changes the speed of the pushing mechanism so as to distribute uniformly the loading of friction of the electrode wire in the flexible tube between the pushing and pulling motors. The pulling motor rotates uniformly, while the pushing motor rotates at a varying damping-increasing speed.

A further possibility is to provide an electric connection between the regulators of both motors only by two wires built-into

the flexible tube, by means of which the power for the motor of the pulling wire-feeding mechanism is supplied.

For a better understanding of the invention and to show how it may be put into effect reference will now be made, by way of example, to the accompanying drawings, in which:—

Figure 1 shows the layout of an arrangement for feeding an electrode wire at long distances in accordance with the invention;

Figures 2, 3 and 4 show the passing of the electrode wire through a long flexible tube between the wire-feeding mechanisms of Figure 1; and

Figure 5 shows by means of a graph the change of the speed of the pushing motor after switching-on the pulling motor.

Figure 1 shows a welding electrode wire 7 which is rolled on a spool 8. The wire 7 is pushed by a planetary roller wire-feeding mechanism 1 (shown merely diagrammatically) inside a long flexible tube 5 in direction E. The motor 3 is shown merely diagrammatically and has its rotor mechanically connected directly to the rollers of the mechanism 1 for rotating them bodily about the electrode wire 7. The motor 3 is supplied from the source 13 of electric current through the regulator 14. The welding current passes along the sheath of the tube 5 through a cable 17. The welding current is thus supplied from the current source 13 towards the place of welding 11.

At the other end of the long flexible tube 5 there is provided a pulling wire-feeding planetary roller mechanism 2, driven directly by the rotor of a motor 4 supplied by the current source 13 through a regulator 9. The speed of rotation of the motor 4 is set and determined by means of a regulating potentiometer 16. The mechanism 2 feeds the electrode wire through a short tube 6 to a welding tool handle 10, from where it feeds the electrode wire 7 towards the place of welding 11. A bridge 18 provides an electric path for the welding circuit between the sheath of the long tube 5 to the sheath of the tube 6, and thence to the handle 10.

Wires 12 which are built into the long flexible tube 5 feed a supply voltage to the regulator 9 of the pulling motor 4. The speed of the latter is preset by means of the potentiometer 16. An electrical resistance 15 is connected in series in the supply circuit of the regulator 9.

Preferably, each of the pushing and pulling planetary wire-feeding mechanisms 1 and 2 is made according to either of the embodiments illustrated and described in British Patent Specification No. 1,320,356, which corresponds to Bulgarian Patent Specification No. 14017. Alternatively, each mechanism could be according to either of the less sophisticated designs as illustrated and described in Bulgarian Patent Specifications Nos. 10986 and 12045.

Driven by the motors 3 and 4, the mechanisms 1 and 2 feed the electrode wire 7 through the long flexible tube 5 connecting the wire-feeding mechanisms 1 and 2. The electrode wire 7 is unrolled from the spool 8. A connection between the motors 3 and 4 is provided by the electric connection of the wires 12 between the regulators 9 and 14 of the motors 3 and 4.

The operation of the arrangement shown in Figure 1 is as follows:

Initially the current source 13 is switched-on and the electrode wire 7 is passed through the long flexible tube 5 and the tube 6 of the handle 10. A contact 19 associated with the handle 10 (or a contact of a relay controlled *via* the handle 10) is open and the motor 4 is stationary. In this position the motor 4 consumes from the current source 13 a negligible current (equal to the excitation current) which produces across the resistance 15 a voltage drop which is insufficient to switch-on the regulator 14. For this reason, also the pulling motor 3 is stationary.

At a given moment the contact 19 is closed, the motor 4 is started, and through the resistance 15 flows a considerable current, the voltage drop of which is fed to the regulator 14, which supplies voltage to the motor 3. The motor 3 is accelerated with the motor 4, but more slowly than the motor 4 because of the characteristics of its regulator. At the same time the pulling mechanism 2 pulls out of the long flexible tube 5 the electrode wire 7, and its quantity there is gradually reduced as the electrode wire is put under tension and thus straightens (see Figure 2). The wire 7 contacts tightly the walls of the flexible tube 5 at the points A, B, C and D thus producing friction. As a result the mechanical resistance in the tube 5 is increased, and since the rollers of the pulling planetary wire-feeding mechanism 2 are directly connected to the axle of the motor 4, the latter is loaded more heavily. Seeking to maintain the speed of the motor 4 constant, the regulator 9 increases the current which is supplied to the motor 4 from the current source 13. This causes the voltage drop on the resistance 15 to increase, thus causing the regulator 14 to increase the current supplied to the pushing motor 3. The latter is accelerated to a speed higher than that of the motor 4, pushing thereby more electrode wire 7 into

the long flexible tube 5 than the pulling head of the planetary wire-feeding mechanism 2 can pick up, thus creating an excess of wire in the tube. In this case the wire contacts the interior of the tube at further points F, G, H, I, J, K, but it is not stretched (see Figure 3). The pulling motor 4 becomes less loaded, this being indicated by a reduction of the current passing through the resistance 15. The regulator 14 correspondingly reduces the power which is supplied to the pulling motor 3, thus reducing its speed considerably. The quantity of electrode wire 7 in the flexible tube 5 is again reduced, the pulling motor 4 is loaded additionally, and the process is again repeated. Only after several fluctuations does the pushing motor 3 equalize its speed with the speed of the pulling motor 4.

When the contact 19 is reopened the pulling motor 4 stops, its consumption drops immediately to its excitation current only, and the regulator 14 stops the power supply to the pushing motor 3 so that the latter stops also.

The character of the change of the speed of the pushing motor 3 as the illustrated arrangement starts up is illustrated in Figure 5, where V_3 indicates the speed of the pushing motor 3 and V_4 the speed of the pulling motor 4.

In the case of abrupt changes in the relative length between the electrode wire 7 and the flexible tube 5, as a result of the bending of the latter, there takes place a stretching of the electrode wire (Figure 2) or a slackening of the electrode wire 7 (Figure 3). Then the length of the electrode wire is relatively greater or smaller than that of the flexible tube 5. In certain severe cases an electric slip may take place between the stator and rotor of the wire pushing motor 3 to absorb the mechanical shock at the pushing mechanism 1, instead of the rollers of the mechanism slipping on the electrode wire 7.

The advantages of the illustrated and described arrangement lie in that is provides the following possibilities: to increase the maximum distance of feeding electrode wire *per* unit electrical power consumed, because of the possibility to use substantially the maximum torque and thus the total rated electric power of the electric motors 3 and 4; reduction and possibly elimination of mechanical slip between the drive rollers and the electrode wire 7 when there occurs a change of length of the electrode wire 7 with respect to the flexible tube 5; to improve the uniformity of feeding and to achieve a stable arc in the case of semiautomatic welding; simplicity of the welding equipment because of the lack of control cables and connections. The connection between both motors 3 and 4 is effected by means of two or the three cable cores in the sheath of a standard tube; a high sensitivity to suddenly arising mechanical resistances and a possibility of rapid restoration of the uniformity of feeding; and a high quality of the fed electrode wire 7 because of the reduction or lack of mechanical slips between the wire 7 and the drive rollers.

WHAT WE CLAIM IS:—

1. A feed arrangement suitable for feeding a welding electrode which is in the form of a wire, the arrangement comprising two feeding mechanisms arranged at opposite ends of a flexible tube through which a wire-form electrode is to be fed in the direction to one from the other of the feeding mechanisms, there being first and second electric motors arranged for driving the one and the other feeding mechanisms respectively, the first motor being operable to drive the one feeding mechanism at a substantially constant rate of electrode feed despite variation in mechanical resistance to the electrode feeding motion and the second motor being arranged to increase and decrease the speed of the other feeding mechanism in response to increase and decrease respectively of the value of the current drawn by the first motor, wherein said one of the two feeding mechanisms is a planetary feeding roller feeding mechanism arranged such that the drive rollers thereof which are arranged to contact the electrode and apply feeding force to it are mechanically connected to the rotor of the associated drive motor without any reduction gearing being connected between said rollers and said rotor.

2. A feed arrangement according to claim 1, wherein said other of the two feeding mechanisms is a planetary roller feeding mechanism arranged such that the drive rollers thereof which are arranged to contact the electrode and apply feeding force to it are mechanically connected to the rotor of the associated drive motor without any reduction gearing being connected between said rollers and said rotor.

3. A feed arrangement according to claim 1 or 2, wherein the first and second electric motors are d.c. motors.

4. A feed arrangement according to any one of the preceding claims, and comprising a spool for electrode wire and a current source for the arrangement both disposed adjacent to the second motor.

5. A feed arrangement according to any one of the preceding claims, and comprising a welding tool with which there is associ-

ated a starting contact for the arrangement and a regulating potentiometer for the first motor.

6. A feed arrangement according to any one of the preceding claims, wherein an electric connection between the first and second motors is provided by two conductors built into the flexible tube.

7. A feed arrangement suitable for feeding a welding electrode which is in the form of a wire, the feed arrangement being substantially as hereinbefore described with reference to Figure 1 of the accompanying drawings.

HASELTINE, LAKE & CO.,
Chartered Patent Agents,

Hazlitt House,
28, Southampton Buildings,
Chancery Lane,
London WC2A 1AT
— also —
Temple Gate House,
Temple Gate,
Bristol BS1 6PT
— and —
9, Park Square,
Leeds LS1 2LH, Yorks.

Agents for the Applicants.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1976.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1 463 004 COMPLETE SPECIFICATION
3 SHEETS

This drawing is a reproduction of the Original on a reduced scale.
SHEET 1

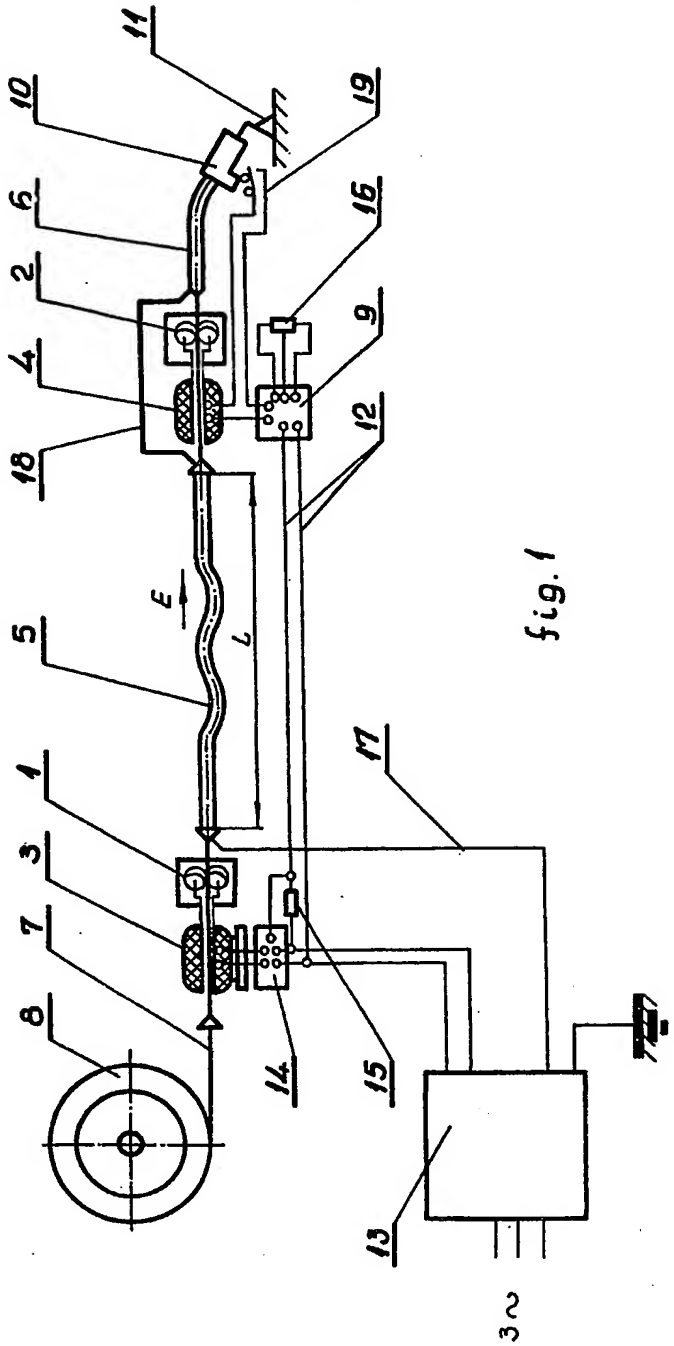
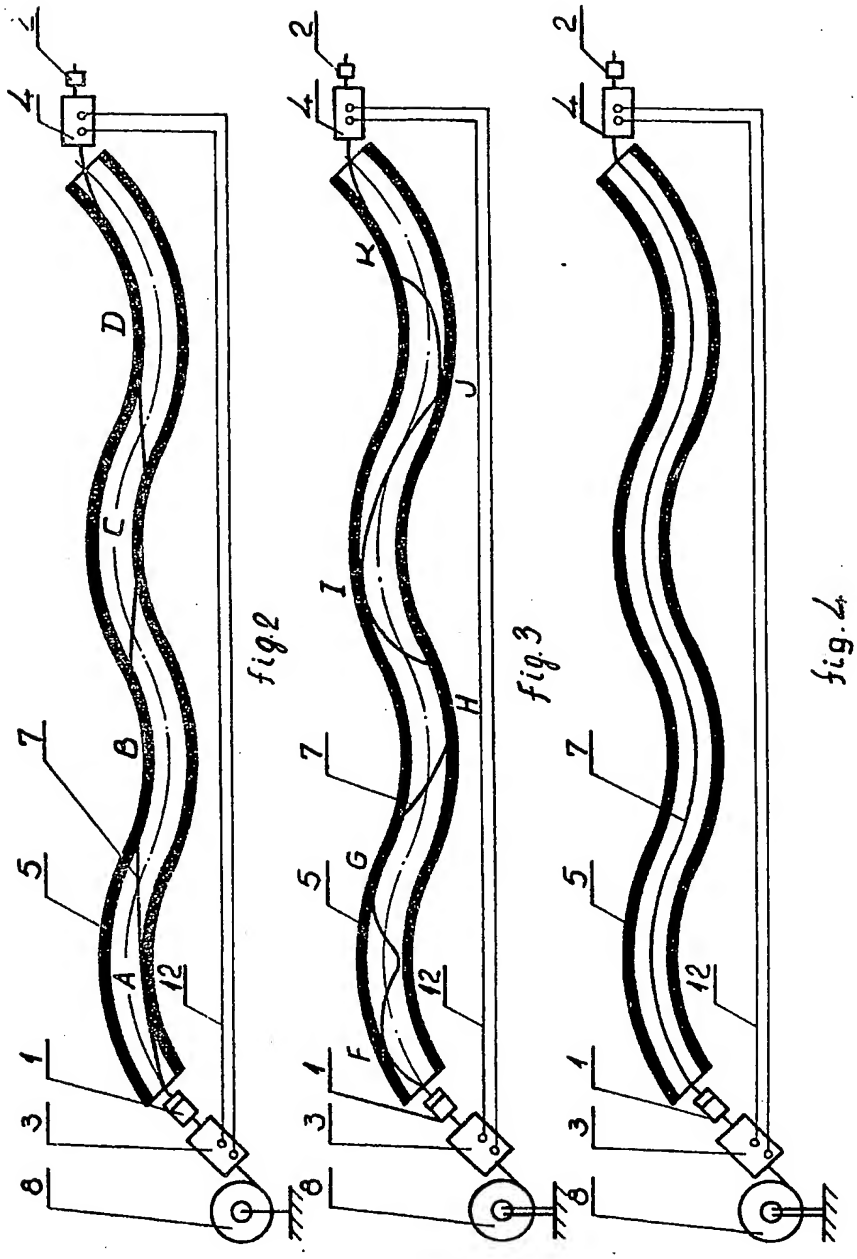


fig. 1

1463004 COMPLETE SPECIFICATION
3 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEET 2



1463 004
3 SHEETS

COMPLETE SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.

SHEET 3

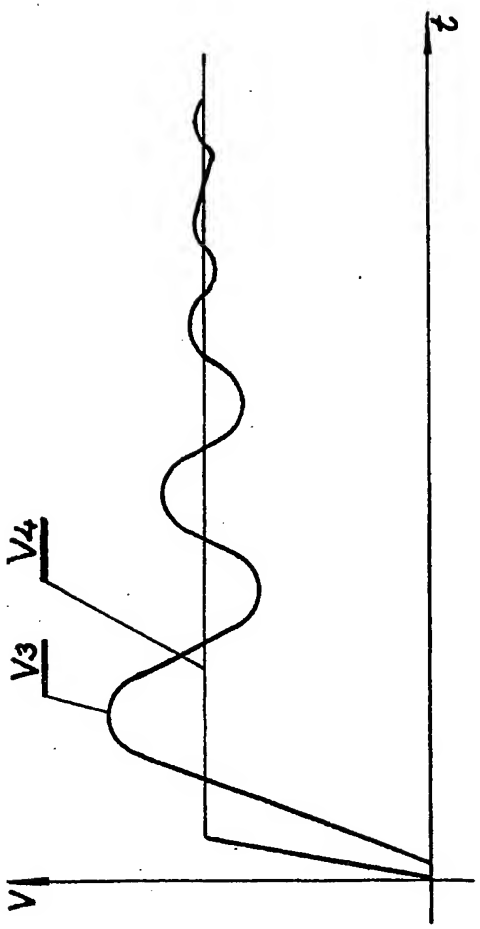


Fig. 5